6606607 E9160n60

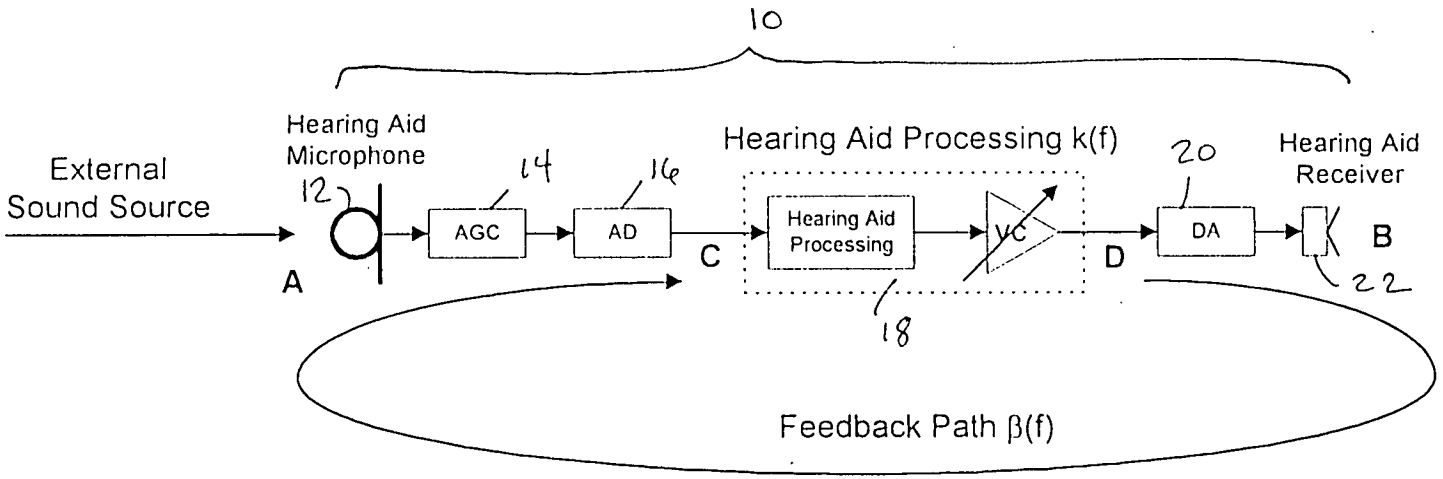


Figure 1:

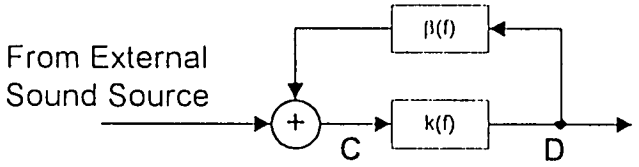


Figure 2:

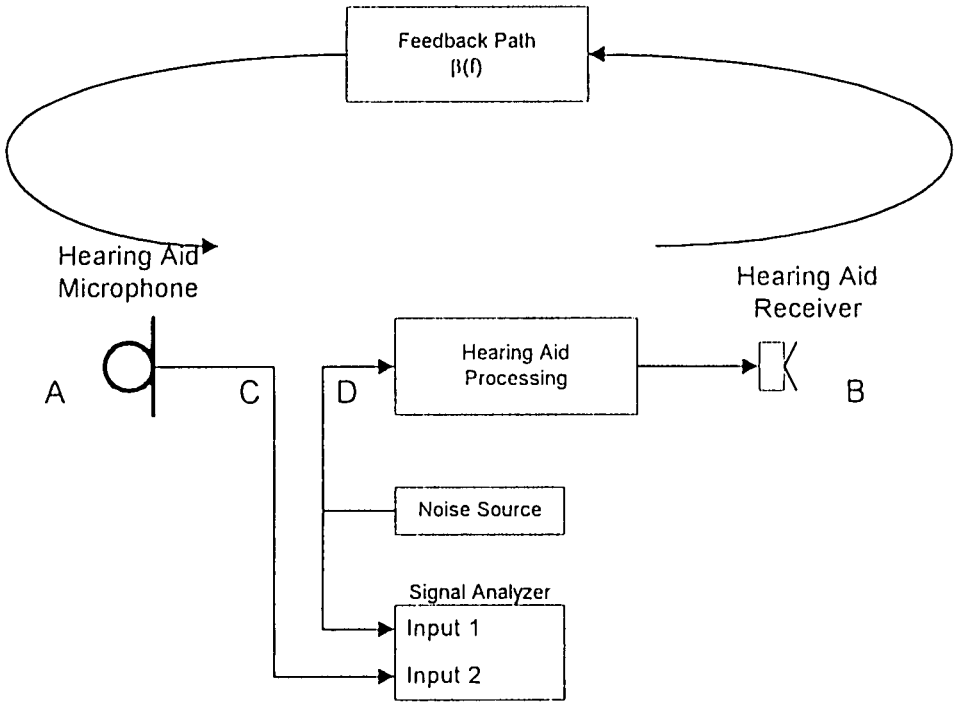

Feedback Path
β(f)
Hearing Aid
Microphone
Hearing Aid
Receiver
Hearing Aid
Processing
A
C
D
B
Noise Source
Signal Analyzer
Input 1
Input 2

Figure 3:

6606601 E9T60T60

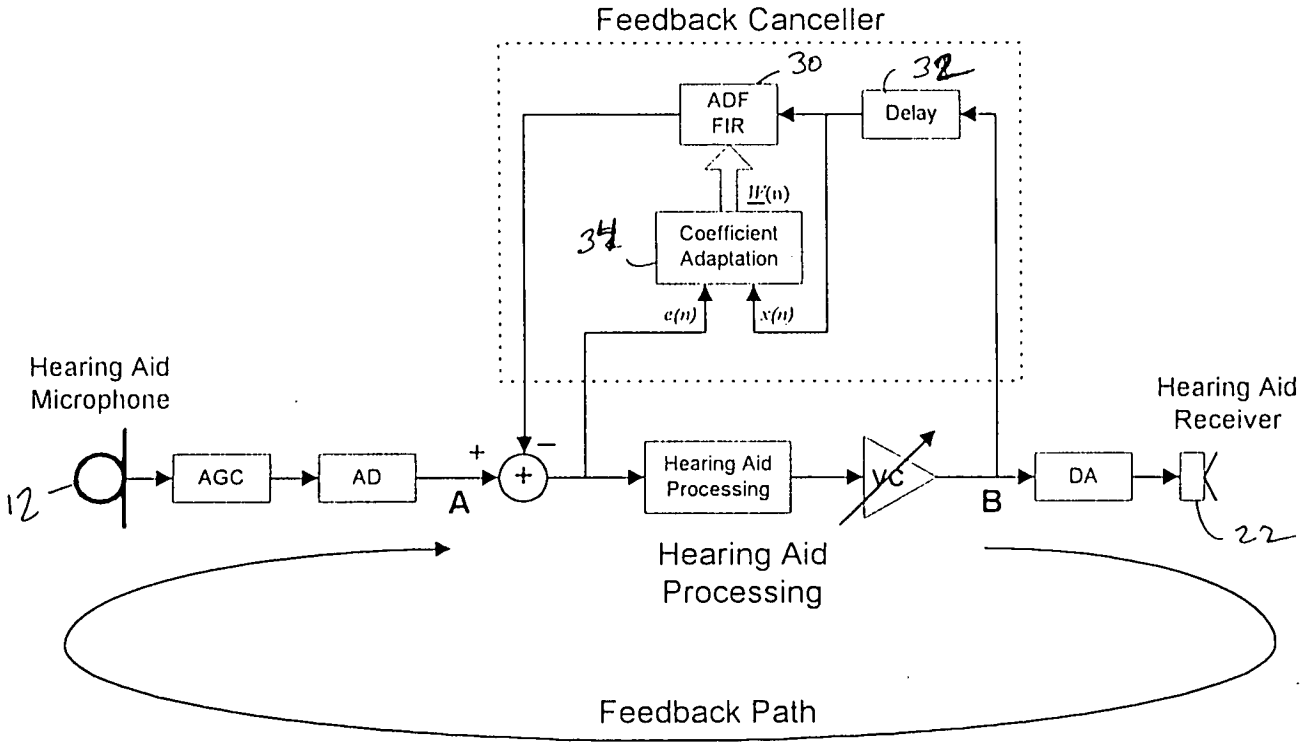


Figure 4:

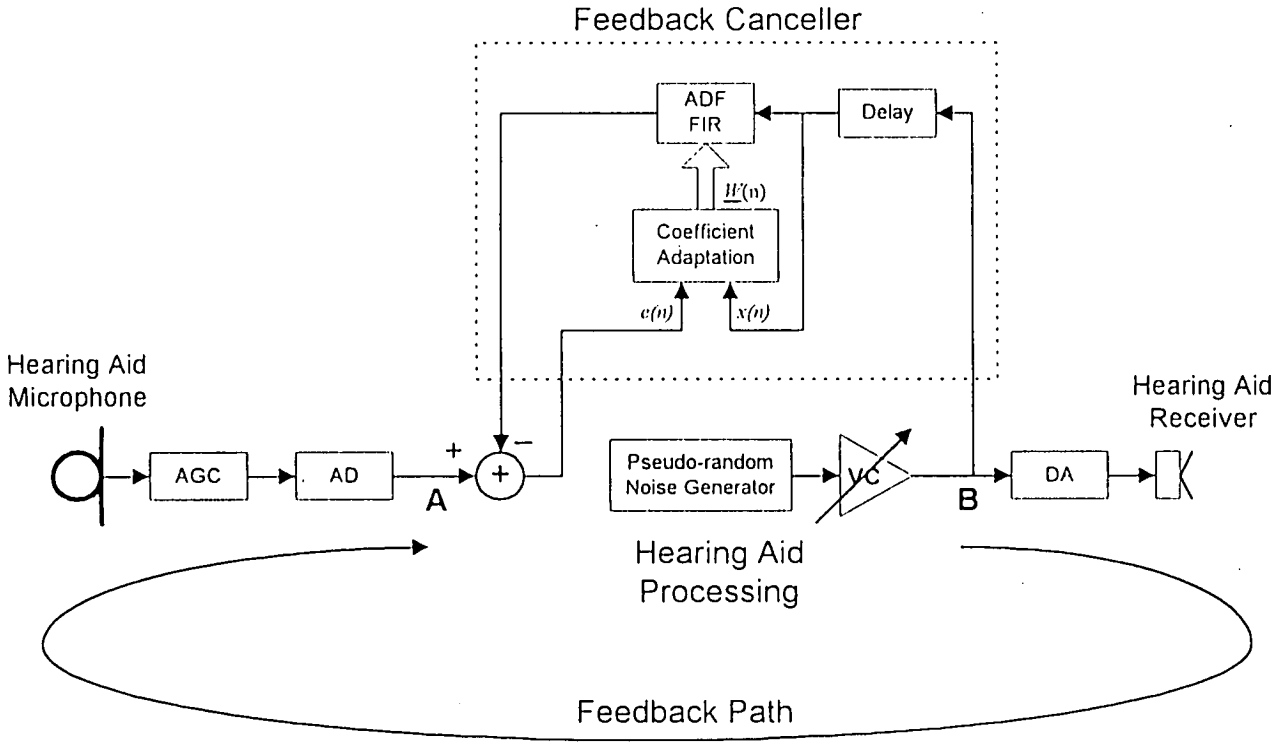

Feedback Canceller
ADF
FIR
Delay
W(n)
Coefficient
Adaptation
e(n)
x(n)
Hearing Aid
Microphone
AGC
AD
+
−
A
Pseudo-random
Noise Generator
VC
B
DA
Hearing Aid
Receiver
Hearing Aid
Processing
Feedback Path

Fig. 5

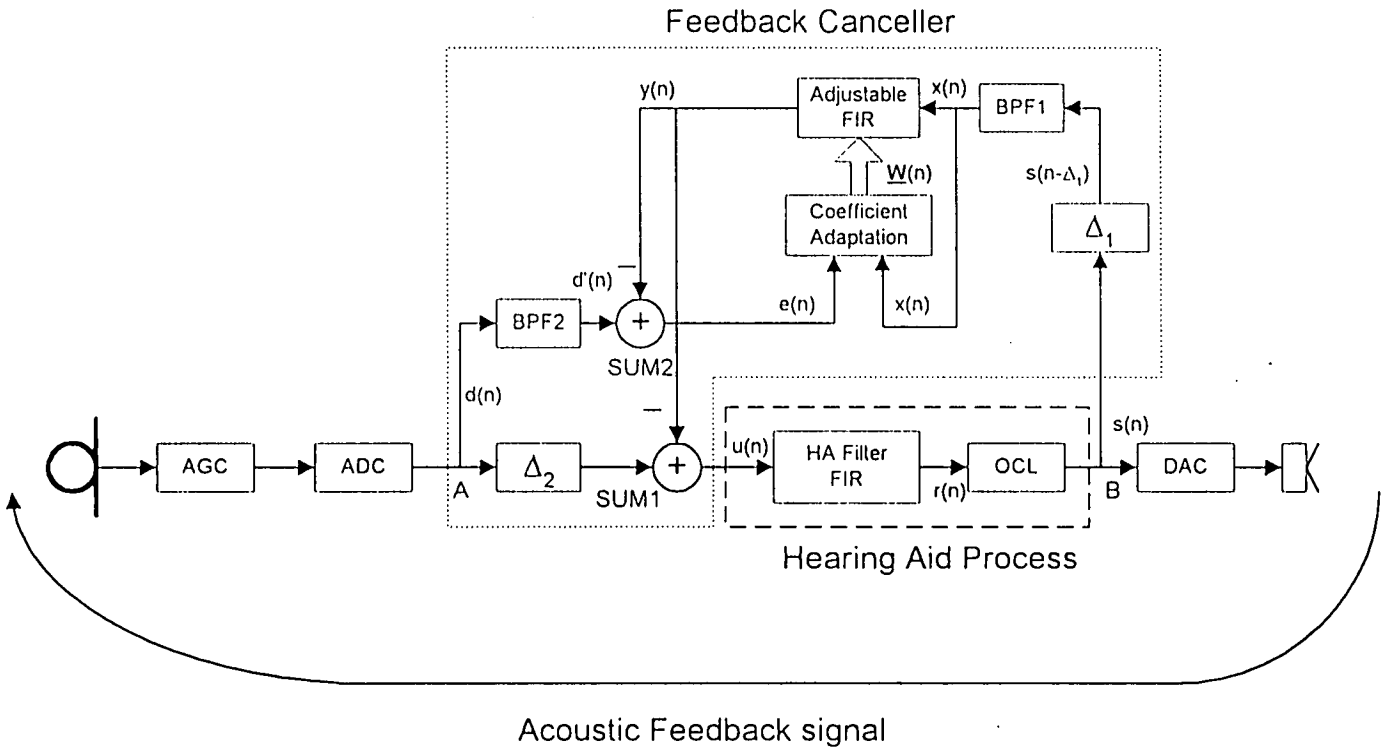

Feedback Canceller
y(n)
Adjustable FIR
x(n)
BPF1
W(n)
s(n-Δ1)
Coefficient Adaptation
Δ1
d'(n)
e(n)
x(n)
BPF2
SUM2
d(n)
s(n)
u(n)
HA Filler FIR
OCL
DAC
AGC
ADC
A
Δ2
SUM1
r(n)
B
Hearing Aid Process
Acoustic Feedback signal

Figure 6:

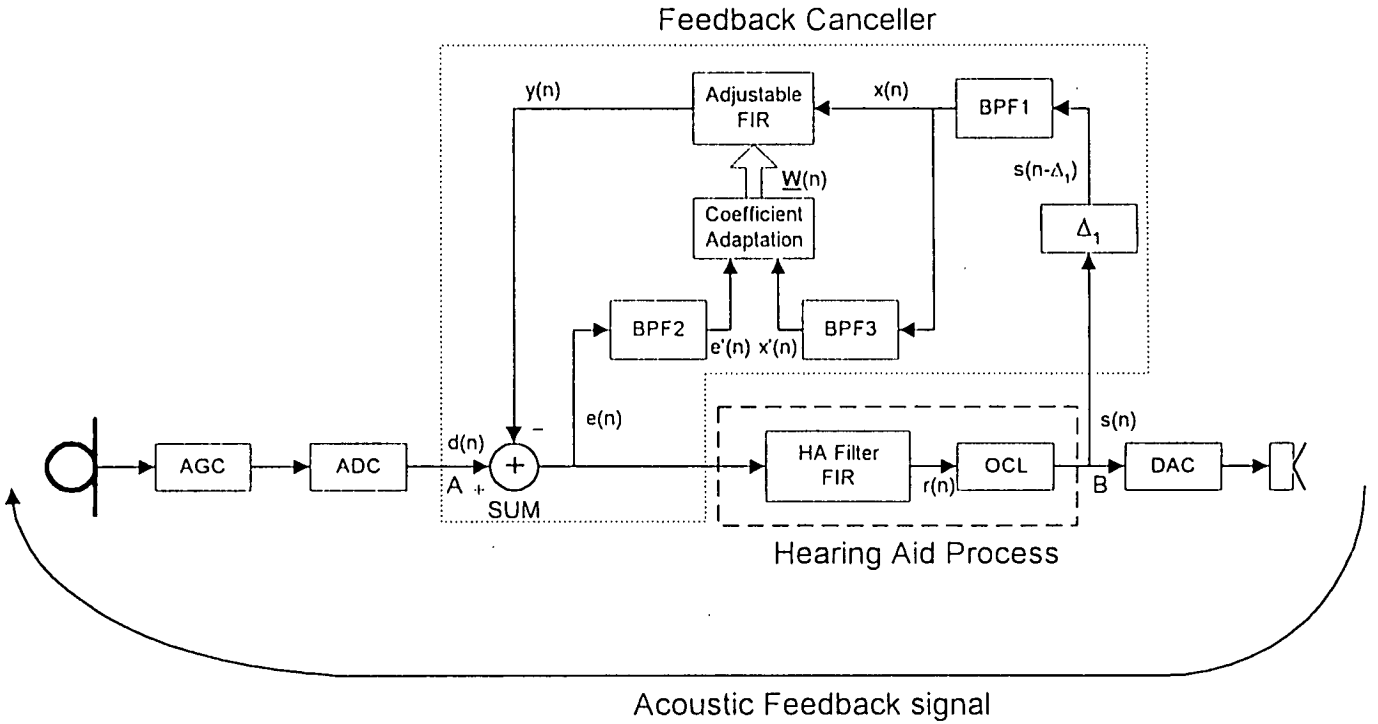

Feedback Canceller
y(n)
Adjustable FIR
x(n)
BPF1
s(n-Δ1)
W(n)
Coefficient Adaptation
Δ1
BPF2
e'(n)
x'(n)
BPF3
e(n)
s(n)
d(n)
AGC
ADC
A
SUM
HA Filter FIR
r(n)
OCL
B
DAC
Hearing Aid Process
Acoustic Feedback signal

Figure 7: .

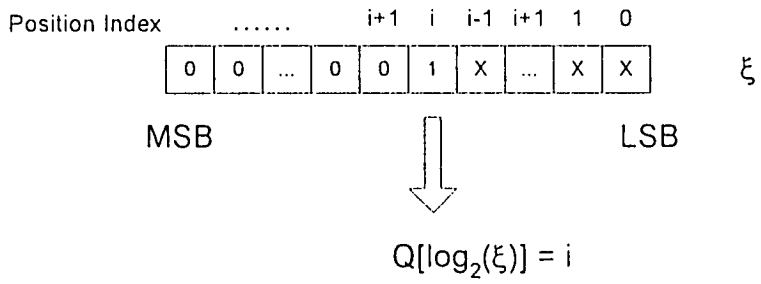


Figure 8:

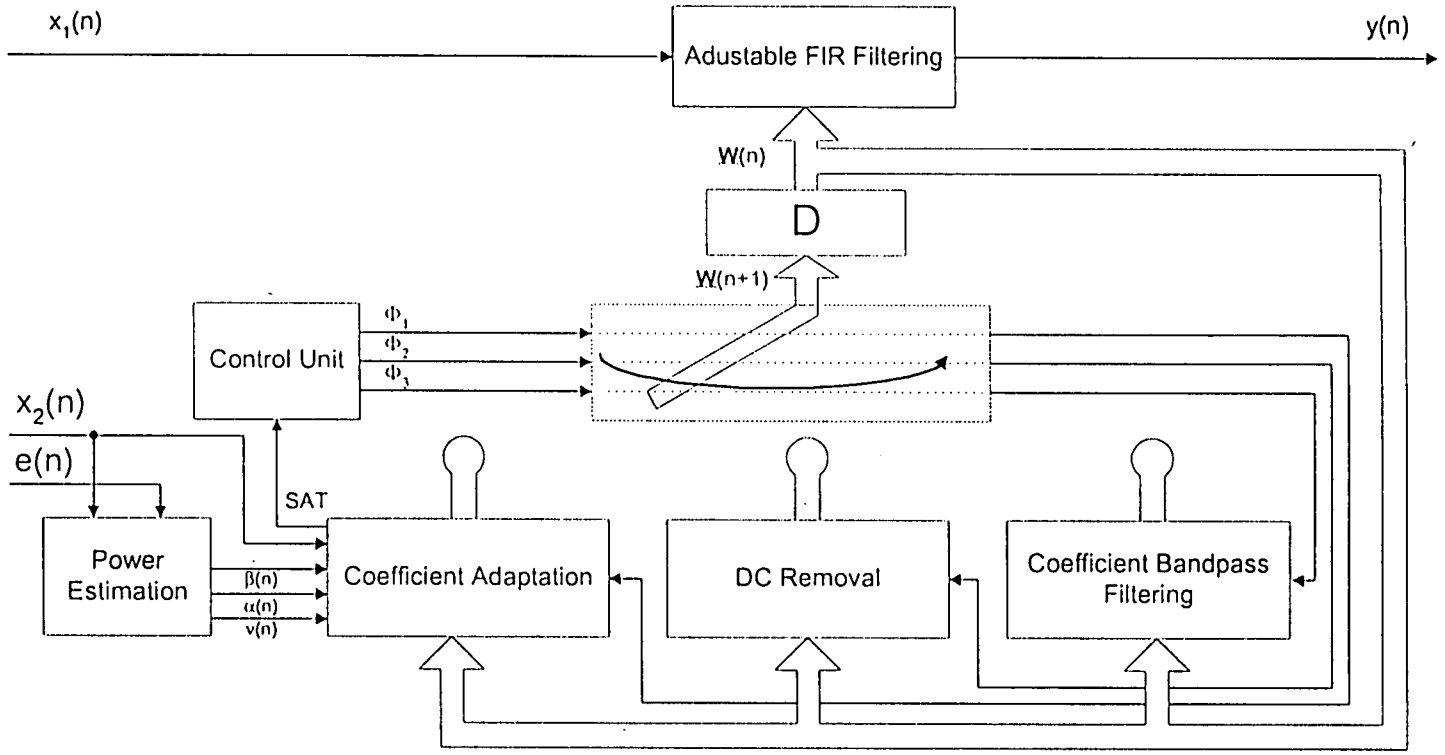

x1(n)
Adustable FIR Filtering
y(n)
W(n)
D
W(n+1)
Control Unit
Φ1
Φ2
Φ3
x2(n)
e(n)
SAT
Power Estimation
β(n)
α(n)
v(n)
Coefficient Adaptation
DC Removal
Coefficient Bandpass Filtering

Figure 9

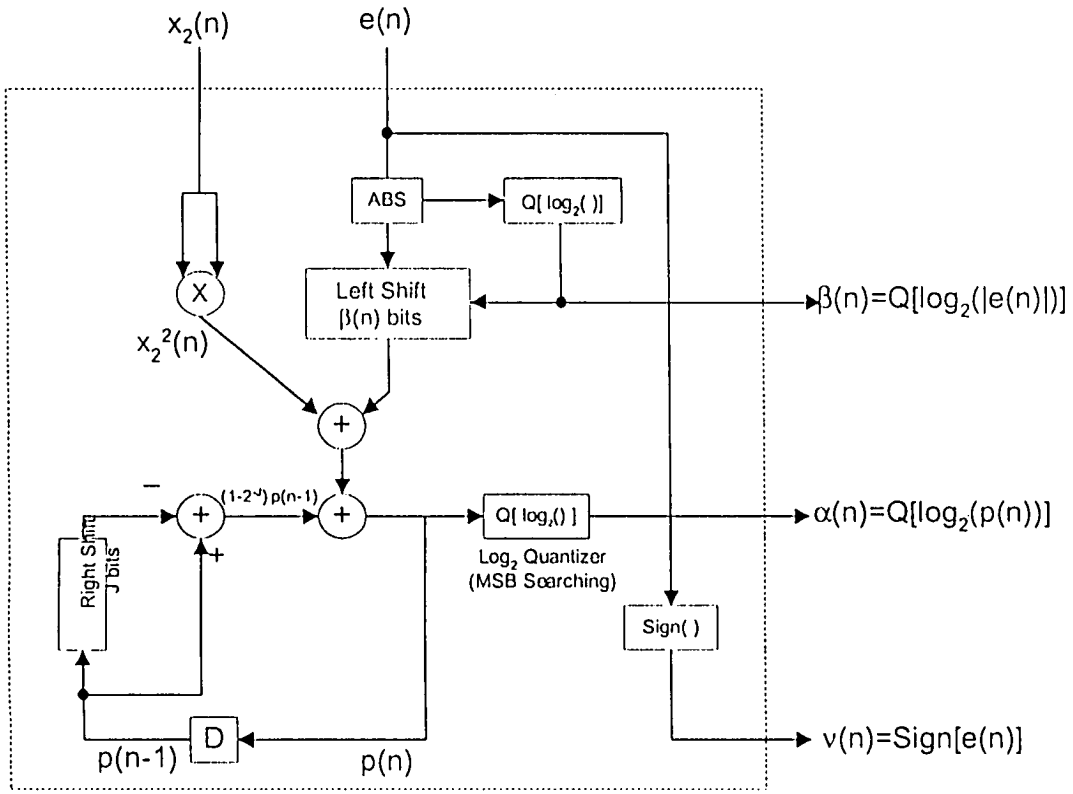

x2(n)
e(n)
ABS
Q[log2( )]
X
Left Shift
β(n) bits
β(n)=Q[log2(|e(n)|)]
x2²(n)
+
−
(1-2^-J) p(n-1)
+
+
Q[log2()]
α(n)=Q[log2(p(n))]
Right Shift
J bits
Log2 Quantizer
(MSB Searching)
Sign( )
D
p(n-1)
p(n)
v(n)=Sign[e(n)]

Figure 10:

660660 "EP1604460

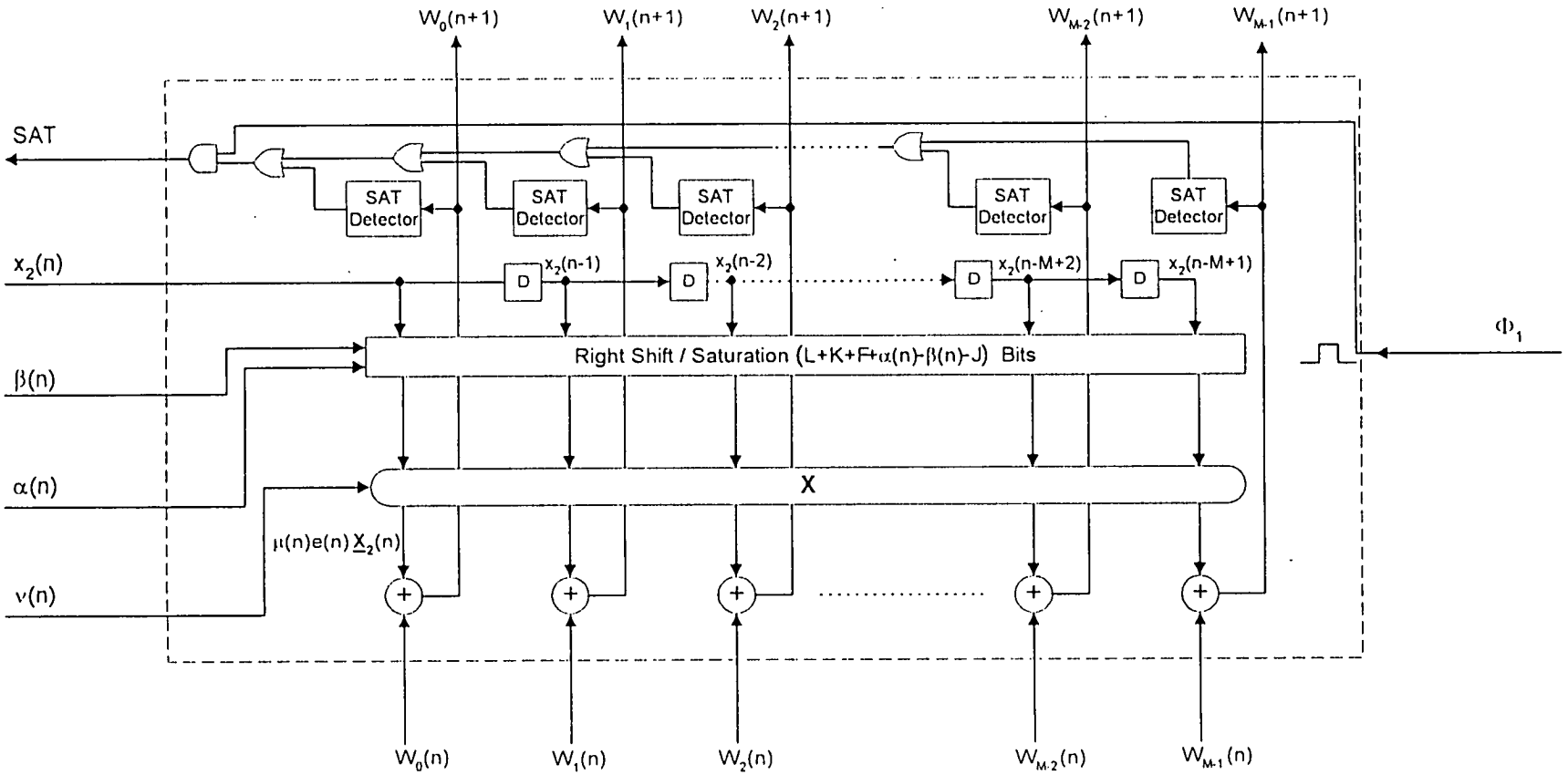


Fig. 11

6606607 E9T60N60

Figure 11: Computational diagram for Coefficient adaptation

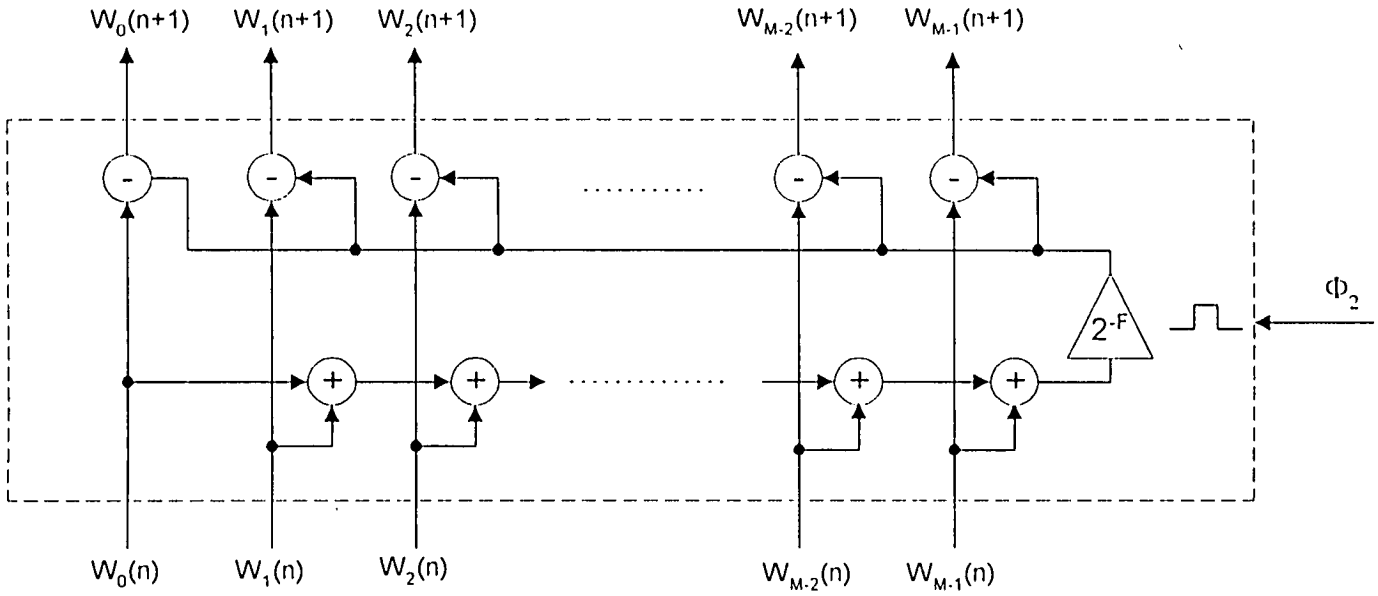


Figure 12:

6,630,860

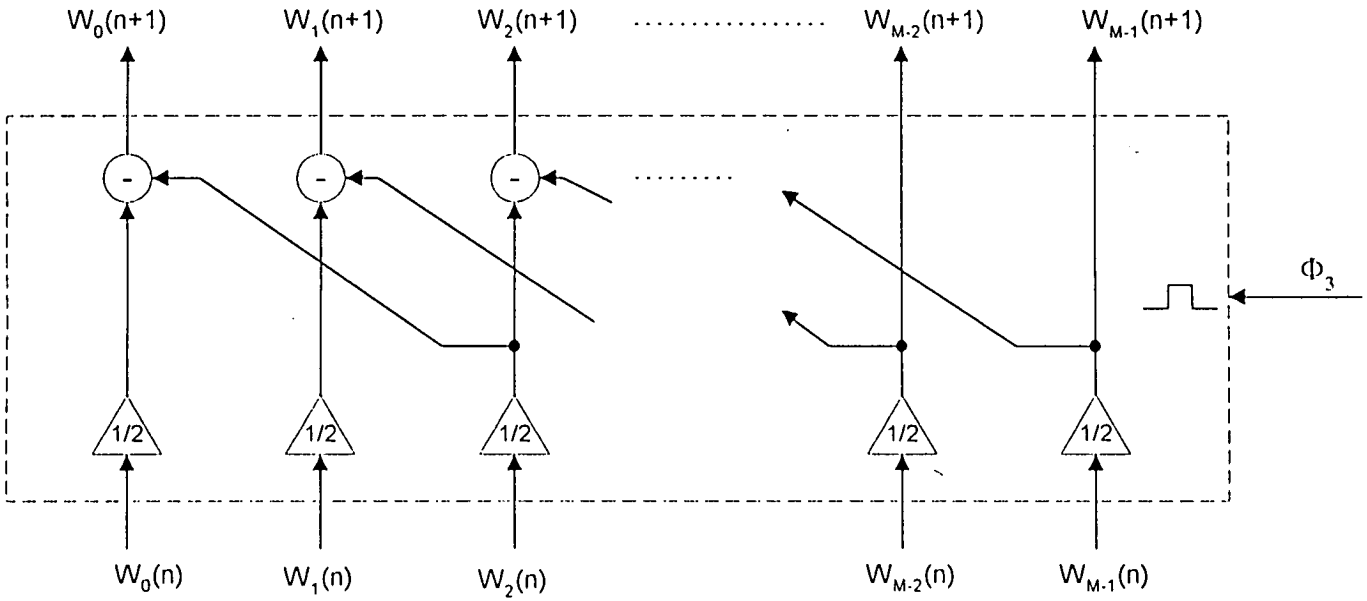


Figure 13:

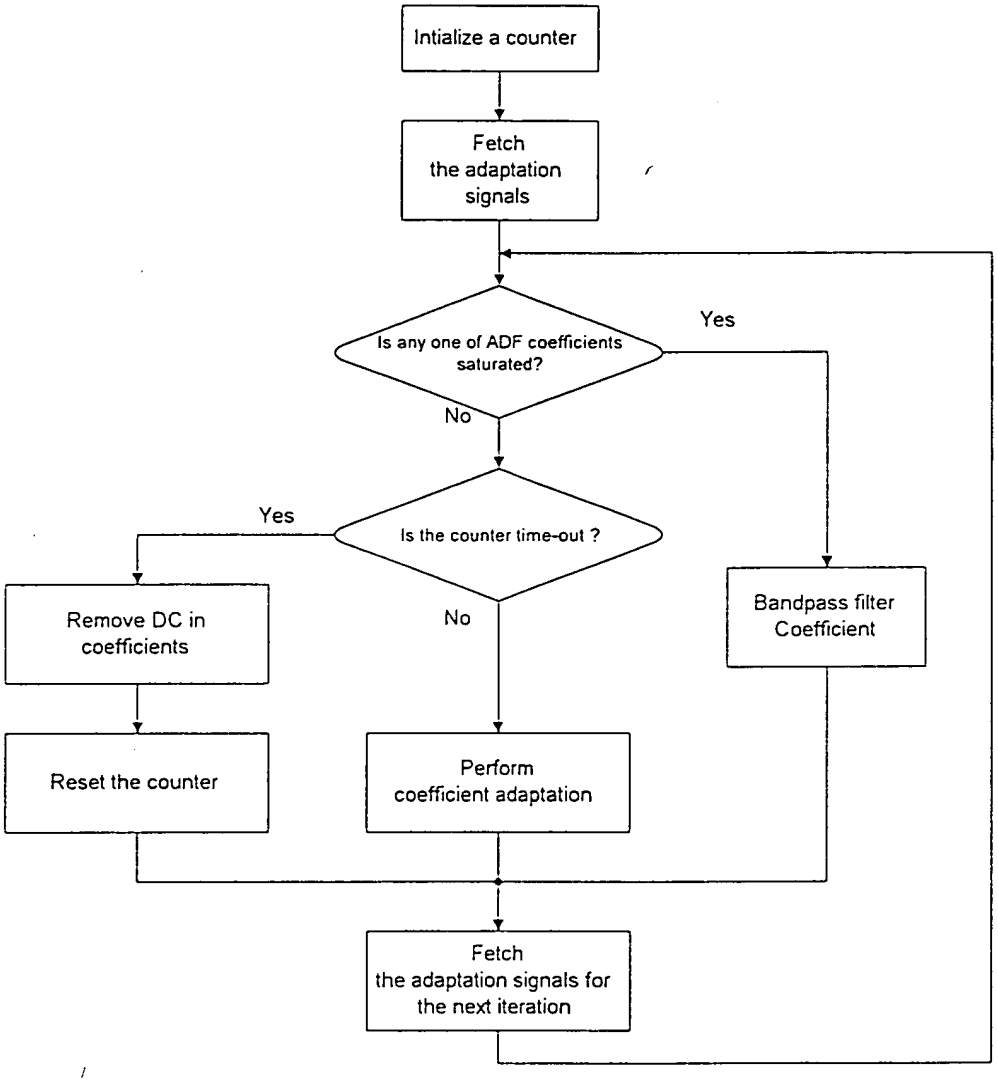
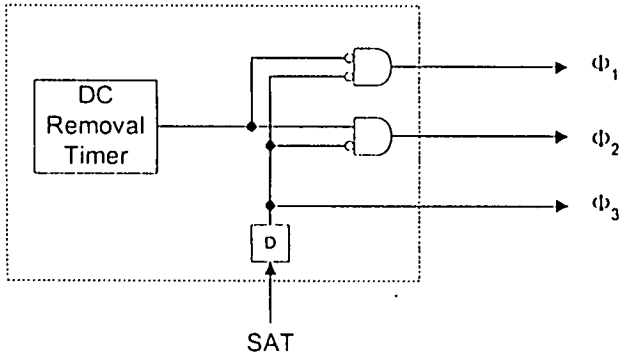

Intialize a counter
Fetch
the adaptation
signals
Is any one of ADF coefficients
saturated?
Yes
No
Is the counter time-out ?
Yes
No
Remove DC in
coefficients
Bandpass filter
Coefficient
Reset the counter
Perform
coefficient adaptation
Fetch
the adaptation signals for
the next iteration

Figure 14:

6860 60" 9160n60



SAT: coefficient saturation indicator from previous sample.
Φ_1: Enable coefficient adaptation
Φ_2: Enable DC Removal.
Φ_3: Enable Bandpassing filtering ADF coefficients.

Figure 15:

6,072,884

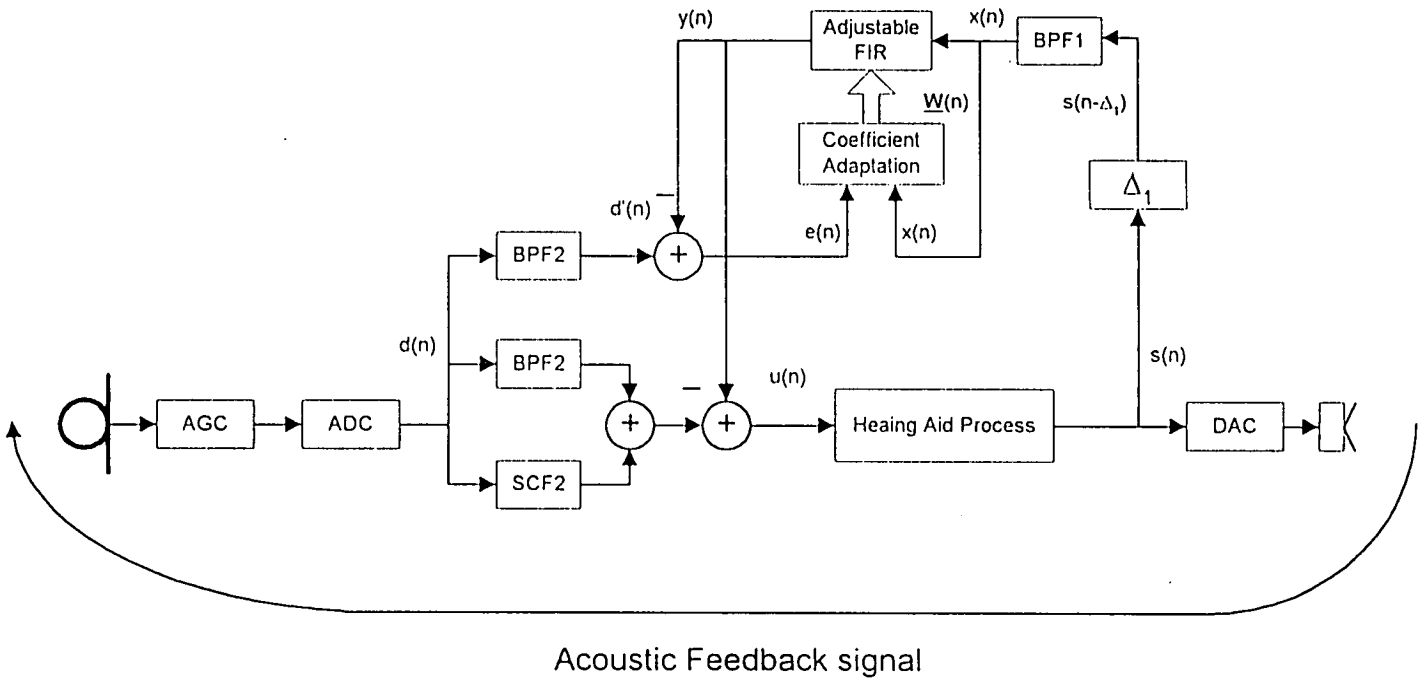


Figure 16:

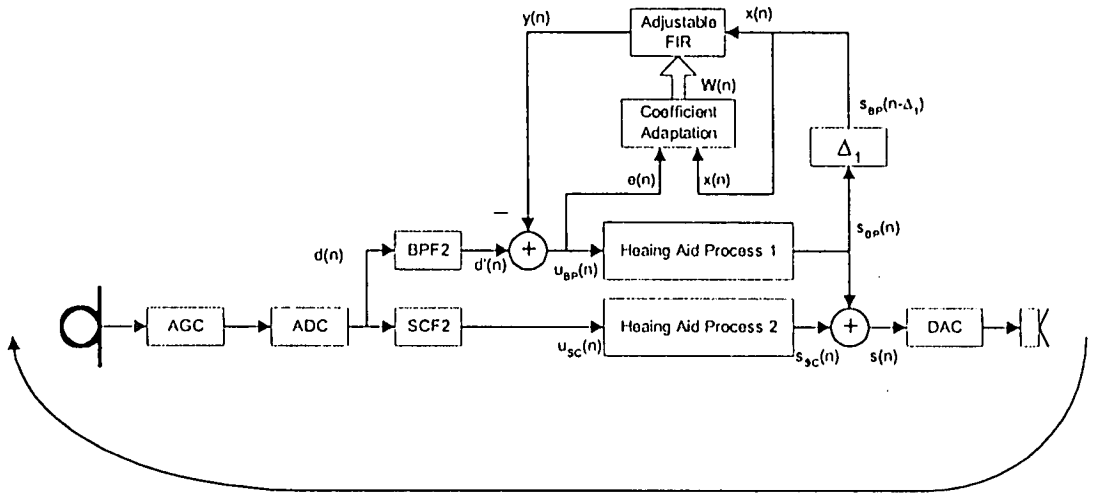

y(n)
Adjustable FIR
x(n)
W(n)
Coefficient Adaptation
e(n)
x(n)
$s_{BP}(n-\Delta_1)$
Δ_1
$s_{BP}(n)$
d(n)
BPF2
d'(n)
$u_{BP}(n)$
Hearing Aid Process 1
AGC
ADC
SCF2
Hearing Aid Process 2
$u_{SC}(n)$
$s_{SC}(n)$
s(n)
DAC
Acoustic Feedback signal

Figure 17:

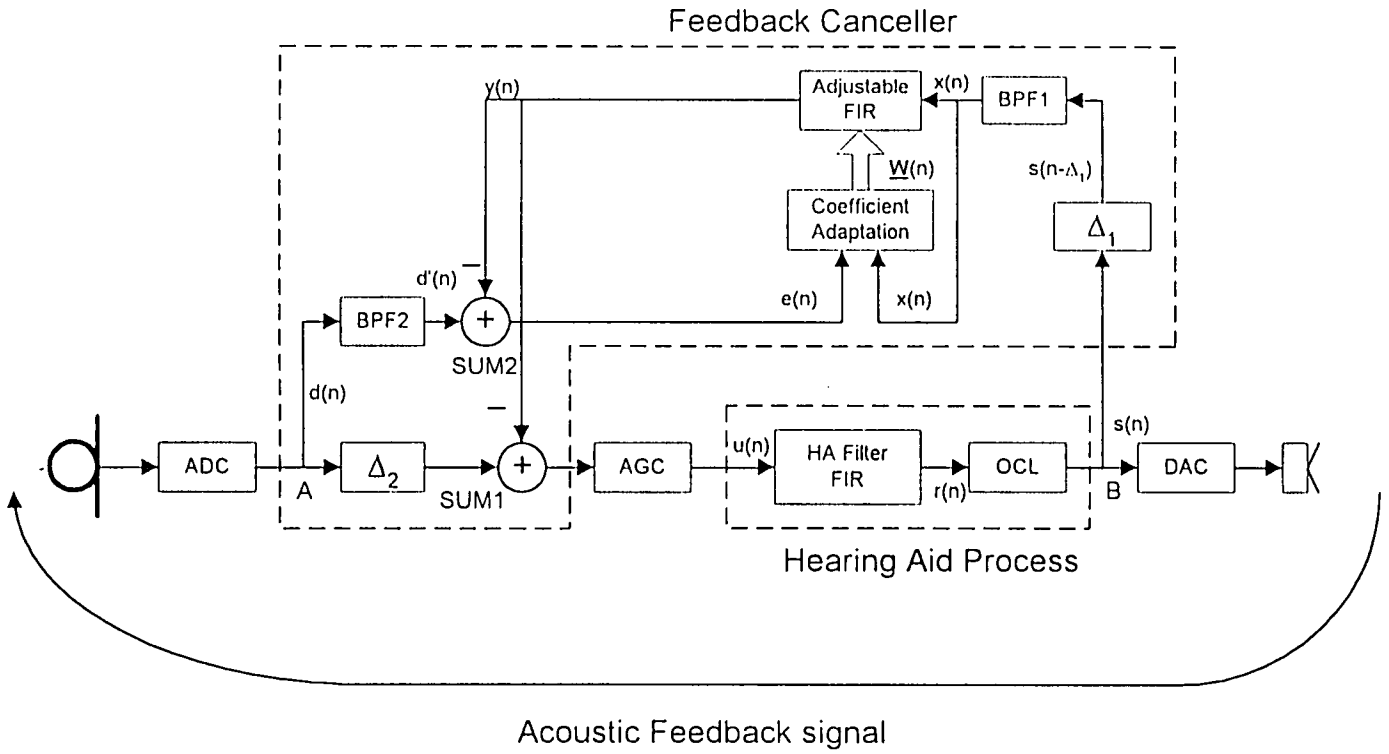

Feedback Canceller
y(n)
Adjustable FIR
x(n)
BPF1
W(n)
s(n-Δ1)
Coefficient Adaptation
Δ1
d'(n)
e(n)
x(n)
BPF2
SUM2
d(n)
s(n)
ADC
Δ2
A
SUM1
AGC
u(n)
HA Filter FIR
r(n)
OCL
B
DAC
Hearing Aid Process
Acoustic Feedback signal

Figure 18:

660660 - E9T60h60

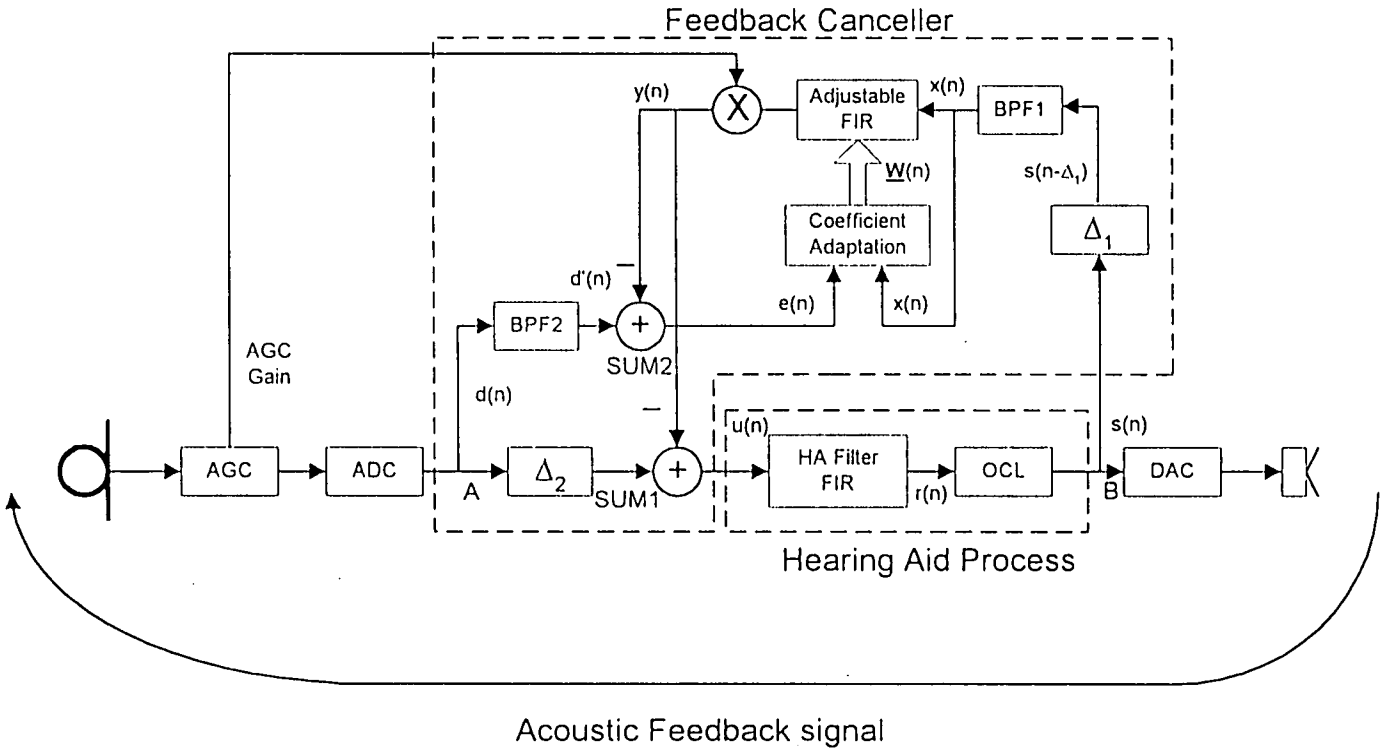


Figure 19:

6860 E96040

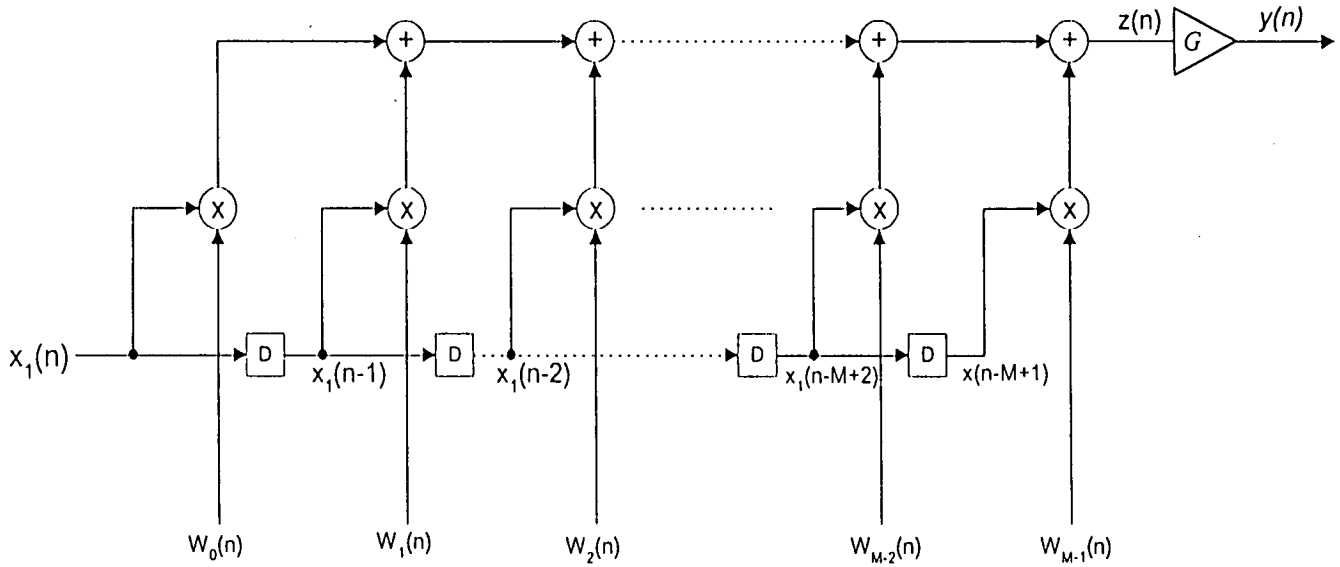


Figure 20 :

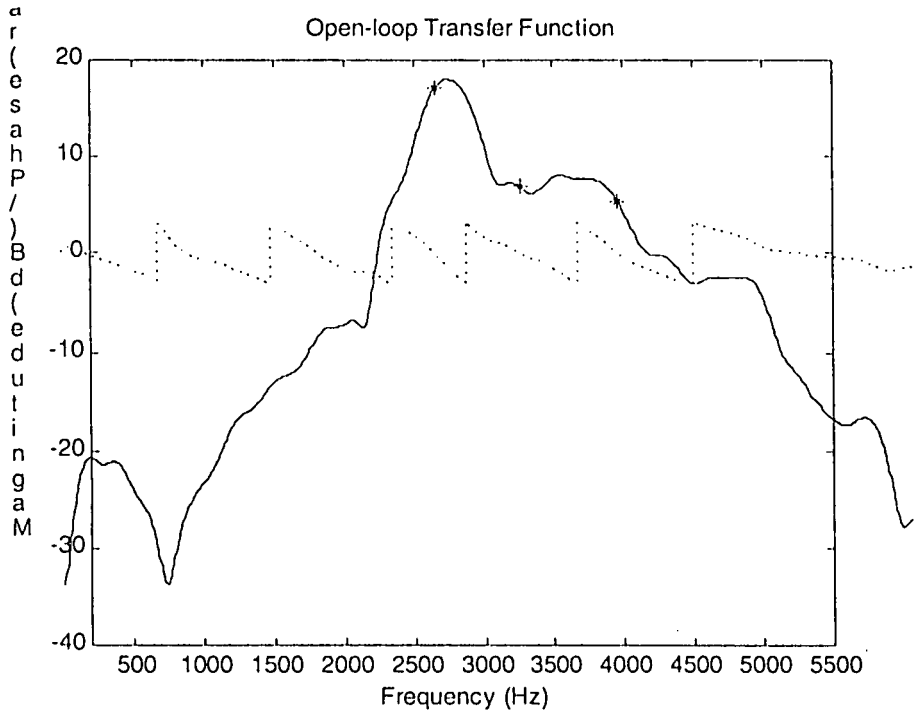

Open-loop Transfer Function
Magnitude (dB)
20
10
0
-10
-20
-30
-40
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
Frequency (Hz)

Figure 21: